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AUTOMATED AIDS TO ON-LINE TACTICAL DATA INPUTTING

Michael H. Strub

Army Research Institute

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AUTOMATED AIDS TO ON-LINE
TACTICAL DATA INPUTTING

M. H. Strub

SYSTEMS INTEGRATION & COMMAND/CONTROL TECHNICAL AREA

U. S. Army

Research Institute for the Behavioral and Social Sciences
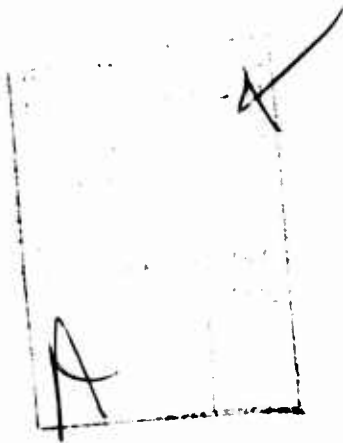
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In an automated information system the input operator must convert free text information into computer-readable format rapidly and accurately as he enters it into the data base.

This report describes and evaluates a computer assisted message inputting (CAMI) aid designed to provide useful additional formatting instructions to operators.

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20. Both a full format and an experimental checklist format were used with the CAMI CRT and with a handbook of instructions and sample formats to input scenario-type messages. Subjects were 60 enlisted men divided into five groups, one for each of the experimental conditions plus one using only the handbook and blank-screen CRT. Speed and accuracy were measured. Speed did not differ significantly among the four experimental conditions, but the fifth unaided condition was significantly slower. No significant differences in accuracy appeared. However, over 80% of the total input errors were discovered to be types of error which are not detectable by present automated error-checking routines.

This report is part of a continuing program in command information processing systems, which provides directly usable design information to the Army Tactical Data System (ARTADS).

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AUTOMATED AIDS TO ON-LINE
TACTICAL DATA INPUTTING

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FOREWORD

To assist the developers and users of current and future Command Systems, the Systems Integration and Command Control Technical Area of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) provides directly applicable empirical information for use in design decisions concerned with such efforts as the Army Tactical Data System (ARTADS). One of the principal problems in military data processing systems has been that computer systems function but are difficult to use except by trained operators. A continuing research program in ARI is directed toward easing and simplifying the man/computer interface and increasing total system effectiveness; the facet of this program reported here concerns the input of information into the computer system. An earlier report (TRN 226) evaluated several techniques for inputting information into a semi-automated information processing system. The present publication examines two alternative methods of formatting free text information into computer-acceptable terminology and evaluates a machine aid which automatically presents information useful in completing the format.

The entire research effort is responsive to requirements of RDTE Project 2Q162106A72I, "Command Information Processing Systems," FY 1974 Work Program, and to special requirements of the U.S. Army Training and Doctrine Command.

J. E. UHLANER
Technical Director

AUTOMATED AIDS TO ON-LINE TACTICAL DATA INPUTTING

BRIEF

Requirement:

To evaluate (1) a computer-assisted message inputting (CAMI) aid that automatically presents information useful for completing message formats and (2) a checklist method of formatting free-text information into computer-acceptable terminology, for on-line inputting of tactical data into an information processing system.

Procedure:

The accuracy and speed of two inputting aids were each compared under two methods of formatting. One aid is a CAMI CRT which offers information, instructions, and lists of legal entries for each item being entered; the other is a looseleaf handbook of instructions, legal entries, and sample messages. In one format method (full), the primary CRT displays all data entry categories and the operator fills in the information he has, leaving the spaces blank where he has no data. In the checklist format method, the operator checks the categories displayed on the primary CRT which he has data for and receives a second display of only those items checked (plus the mandatory entries). Results from the four experimental conditions were also compared with those from a fifth condition in which the operator used only the handbook and a blank-screen CRT. Subjects were 60 enlisted men who were divided into five groups and assigned to the five conditions to provide data for an analysis of variance. The messages were from a tactical scenario, one type transmitting data about the enemy and nine types transmitting data about friendly troops.

Findings:

No significant differences in accuracy or speed could be attributed to use of the CAMI aid or the checklist format. The fifth, blank-screen condition required significantly longer (an average 4.6 minutes per message) than the comparable full format or checklist handbook conditions. "Friendly" messages were completed with greater accuracy and speed than "enemy" messages, perhaps because they may have been simpler to format.

An unexpected but important finding was that over 80% of the total input errors were types which would not have been detected by a computer error-checking routine.

Utilization of Findings:

Some types of input errors are detectable by computer error-detection programs, but many are not. If total error rates are separated into their component categories, the probable ratio of detectable to undetectable errors can be determined, and the frequency of undetected errors in a real-world on-line situation can be estimated.

Since computerized error detection is not likely to be a complete solution to the problem of accuracy, operator proficiency will continue to be of great importance. The possibility might be considered of incorporating an on-line instruction program into the system for use in a tactical situation where trained replacement operators may not be available.

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BACKGROUND

Computer-Assisted Message Inputting

Computer technology is experiencing growing pains. Initial emphasis in system design was on solving hardware and software problems such as determining necessary computer equipment and selecting and/or developing the necessary programs. The result of this emphasis is evident today: Computer systems function but are difficult to use by anyone except highly trained operators.

Army tactical data systems are presently investigating ways to simplify the task of translating free text message information into computer-acceptable terminology. Unless the automated system is comparable or superior in ease of use to the manual system, potential gains in accuracy and speed of information flow will not be realized. A message-input-output-device (MIOD) operator finds it hard to appreciate the benefits of the automated information system when he has to struggle to enter any data.[1] Therefore, the task of inputting information should be simplified. This simplification should neutralize a major source of user irritation and thereby highlight the benefits of the system. Only in a non-threatening environment will an atmosphere conducive to user acceptance be created. As stated by Baker et al,[2] "Further it is realistic to expect that the introduction of ADP into tactical operations will produce new human performance problems. Solutions to these problems therefore become of paramount importance."

One promising approach to helping the operator input information into a computer data base is to use the computer's ability to instruct the operator while he is performing his task. Observation of field grade officers retrieving information from a computerized data base in ARI's simulated tactical operations system (SIMTOS) experiments[3] suggested

[1] See Baker, "An assessment of the impact of automation on Seventh Army users" on user attitude toward the introduction of automated equipment (in preparation).

[2] Baker, J. D., D. J. Mace and J. M. McKendry. The transform operation in TOS: Assessment of the human component. ARI Technical Research Note 212. August 1969. (AD 697 716)

[3] Robins, J. E., L. Buffardi and T. G. Ryan. Research on tactical military decision making: Application of a decision prediction concept in a SIMTOS environment. ARI Technical Research Note 246. March 1974. (AD 708 812)

that officers quickly feel at ease interacting with the computer when procedural instructions are explicit. Such an approach should facilitate inputting as well as retrieval of data. Thus, a principal objective of the present research was to find out the relative improvement in inputting performance which could be expected if the instructional capabilities of the computer were increased. For ease of reference, this approach will be called CAMI (computer-assisted message inputting).

Consolidation

A previous study[4] had concluded that "efforts should be directed toward changing rather than aiding the present TOS (Tactical Operation System) transform process." It pointed out the redundancy of having the action officer select a paper format, fill it out, and hand it to an input operator. The report recommended that one man transform the message directly onto the CRT screen. Strub found experimentally that significantly fewer errors were made when the message was input directly on the CRT than when paper formats were used as an intermediate step (11.2% error vs 14.8%).[5]

A second recommendation about changing the TOS transform process was made by Baker et al:[6]

> One task that should be undertaken is that of scrutinizing existing formats to determine if the absolute number can be reduced. Considerable overlap in content exists among the present formats. Certain formats could conceivably be combined because of this communality.

In early 1972, the Intelligence and Control Systems Group (INCSG) of the Combat Developments Command (CDC) established a Format Revision Committee with representatives from Project MASSTER, the Computer Systems Command, Army Tactical Data Systems, and ARI. In February of that year, they conducted a test at MASSTER to assess the extent, if any, to which consolidation of message formats would enhance user performance without lessening the acceptability of message processing procedures to the user.

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[4] Ringel, S., J. D. Baker, M. H. Strub and L. L. Kensinger. Human factors research in command information processing systems--summary of recent studies. ARI Technical Research Report 1158. July 1969. (AD 694 347)

[5] Strub, M. H. Evaluation of man-computer input techniques for military information systems. ARI Technical Research Note 226. May 1971. (AD 730 315)

[6] Baker et al., 1969, op. cit.

The dependent variable was time. Results of the test indicated that the use of consolidated formats produced an average savings of 49 seconds per input message compared to the time using unrevised input formats.

In addition, ARI and CDCINCSG discussed aiding the on-line tactical data inputting process with CAMI and strategies for reducing the number of characters required to input a message. If such reduction were provided, the savings in space could be used either to reduce the size of the input device or add inputting instructions to the CRT format display.

Research Objectives

As a result of these meetings, ARI conducted an experimental investigation of (1) a CAMI aid and (2) a method for reducing the number of characters necessary to input a message. The CAMI aid consisted of a second CRT display which displayed item by item instructions and tables of permissible codes (legal entries) and abbreviations.[7] The character reduction method consisted of a checklist display of the optional categories of information contained within a selected format. Prior to inputting a message, the subject first selected from this list only those categories called for by the data in that particular message. He then received a format containing only mandatory entries and those entries which he had selected. The primary objective of the present experiment, then, was to evaluate (1) a CAMI aid which automatically presented (via a second display device) information useful for completing the format, and (2) a checklist method of formatting free-text information into computer-acceptable terminology.

A secondary objective was to evaluate a method of inputting with no computer assistance; that is, the subject accomplished the free-text to computer-entry translation task given only a blank screen and a handbook of instructions. While this method minimized the number of characters needed for a display device, the absence of a format display or machine display of message-composition information was expected to be detrimental to performance. However, such a condition would provide baseline data for comparison with the experimental aids investigated here.

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[7] TOS[2] specifications call for a split screen capability. Two screens were used in the present experiment for ease of programming. A minor software modification would incorporate the material displayed on two screens onto a single split screen.

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Subjects

Sixty enlisted men, each with a GT score of 110 or above and normal or corrected vision, participated. Four men a day completed as many messages as possible during a morning session (0800-1200) and an afternoon session (1300-1700).

Equipment

The experiment required six cathode ray tube (CRT) keyboard displays and four 1050 Selectric typewriters, located in the ARI Training and Information Systems Facility and wired to a 32K computer. The CRTs displayed formats and composition information, and the typewriters simulated teletypewriters and typed out simulated free-text messages from the field. Necessary manuals and handbooks were provided for those experimental conditions involving manual reference to glossary information.

Procedure

At the start of each session, the experimenter welcomed the subjects and briefed them on the general purpose of the experiment in which they would participate. Each subject was then seated in a cubicle and requested to read three typed pages of orientation material. The first page repeated the general purpose of the experiment (i.e., to test the relative effi-ciency of several methods of entering data into a military computer) and stressed the importance of accuracy over speed. This page is reproduced in the Appendix. The second page was a situation report describing scenario background events. According to the scenario prepared for the experiment, each subject assumed the role of MIOD operator in the HHC of the 1st Battalion, 2d Armor, a unit under the 1st Brigade 52d Infantry Division (Mechanized). The subject was told that the messages which he would be processing derive from the following background events:

> "In the early morning hours, your unit was attacked by
> strong elements of the Circle Trigon Government's 2d
> Tank Army. Though surprised and outnumbered, your unit
> recovered quickly, fought a successful delaying action,
> and finally withdrew in good order, sustaining minimal
> losses. Morale remains excellent."

The third page contained general instructions for inputting a message.

After the subject had read these pages, the experimenter showed him how to input the message on-line using a practice message. After completing one practice message with the subject and answering any procedural

questions, the subject was left to start the first scenario message on
his own. He was instructed to contact the experimenter via a phone
located in his cubicle if he had additional questions.

The scenario prepared by CDCINCSG contained 49 messages for each
subject to process. Each message was typed out automatically by a
computer-driven typewriter. After a message was typed out, the subject
tore it off, called up the appropriate format via his CRT and began to
format the contents of the message. Of the 49 messages, 38 required one
format to complete, 7 required two formats, and 4 required three formats
for a total of 64 formats. When he had completed all formats required
by a message and entered the information into the computer data base,
the next message began to type out.

Ten different format types were used in the experiment. The
frequency of use of each type is shown in Table 1.

Table 1

FREQUENCY OF USE OF EACH FORMAT

Name	Frequency
Intelligence (1 Format)	
Enemy Situation Data Message	36
Friendly Operations (9 Formats)	
Front Line Trace Data Message	7
Command Post and Center of Mass Data Message	3
General Outpost and Combat Outpost Data Message	8
Operational Area Data Message	2
Phase Lines Data Message	2
Axis of Advance and Direction of Attack	2
Objectives Data Message	2
Movement Control Points Data Message	1
Fire Control Lines Data Message	1
	64

The format selection process was not investigated in the present experiment, as this process has been examined in an earlier ARI research project.[8]

The experimental conditions are shown in Figure 1. In each of the first four conditions, automatic tabbing was provided. That is, after completing each data entry item the subject was instructed to press the "send" button (transmit key) which automatically moved the cursor to the next entry item, eliminating the need to space over from one item to the next. In condition I, the subject called up a full format such as the one shown in Figure 2 with the cursor (solid line) positioned under the first space of an entry item. A second CRT (CAMI), positioned beside the first, displayed instructions and tables of legal entries, where appropriate, for the particular item the subject was completing. For example, the first CAMI display for the sample format in Figure 2 is shown in Figure 3a. After the subject entered a message number and pressed the send button, the cursor on the input CRT would move to the next entry (precedence = PREC [ ]) and the display shown in 3b would appear on the CAMI CRT. The subject would continue to complete data entry items (skipping over items for which the message contained no data) in this manner until he reached the end of the format.

In condition II (see Figure 1), only the input CRT was used. To complete the format, subjects in this condition referred to instructions and tables of legal entries contained in a manila folder which served as a handbook. The handbook also contained a sample message worked out for each format type. In all other respects, condition II was similar to condition I.

Condition III contained an extra step. When the subject called for a format, instead of receiving the full format such as shown in Figure 2, he received a checklist of format items such as shown in Figure 4. He proceeded to type an "X" to the left of each entry for which the message contained data. After selecting the required items, he pressed the "send" button and received a format which consisted of only mandatory entries and those items he selected. For example, if the message contained no data for "RESTR" or any item below " -CO-ON-LINE-POSIT" in Figure 4, he would leave these entries blank and put an X beside the others. Upon pressing the send button, he would see the display shown in Figure 5. For each item selected by the subject in Condition III, he received corresponding instructions and legal entries tables on a CAMI CRT. Condition IV followed the same checklist procedure, but the subjects did not have the CAMI CRT and were required to consult their handbooks for instructions and tables of legal entries.

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[8] Baker et al., 1969, op. cit.

Conditions

I — Input CRT / CAMI CRT — Instructions, codes. legal entries — Full format

II — Input CRT / CAMI CRT — Handbook of instructions, codes, legal entries — Full format

III — Input CRT / CAMI CRT — Instruction, codes, legal entries, for selected items only — Format checklist - then selected items

IV — Input CRT — Handbook of instructions, codes, legal entries — Format checklist - then selected items

V — Input CRT — Handbook of instructions, codes, legal entries — No format - blank screen

Figure 1. Experimental conditions

```
                    UCl FLT COORD DATA
cursor
─────────────────────┐
                    MSG-NR[▊      ]PREC[ ]SCTY[ ]ORIG[      ]RESTR(      )
                    UNIT-ID-OR-TF-NAME[                     ]
                    FLT-COORD-1(          )FLT-COORD-2(      )
                    FLT-COORD-3(          )FLT-COORD-4(      )
                    FLT-TIME(          )
                    CO-ON-LINE-POSIT( / )
                    BN-ON-LINE-POSIT( / )
                    LT-COORD-PT(          )
                    LT-COORD-PT-TIME(             )
                    RT-COORD-PT(        )
                    RT-COORD-PT-TIME(             )
```
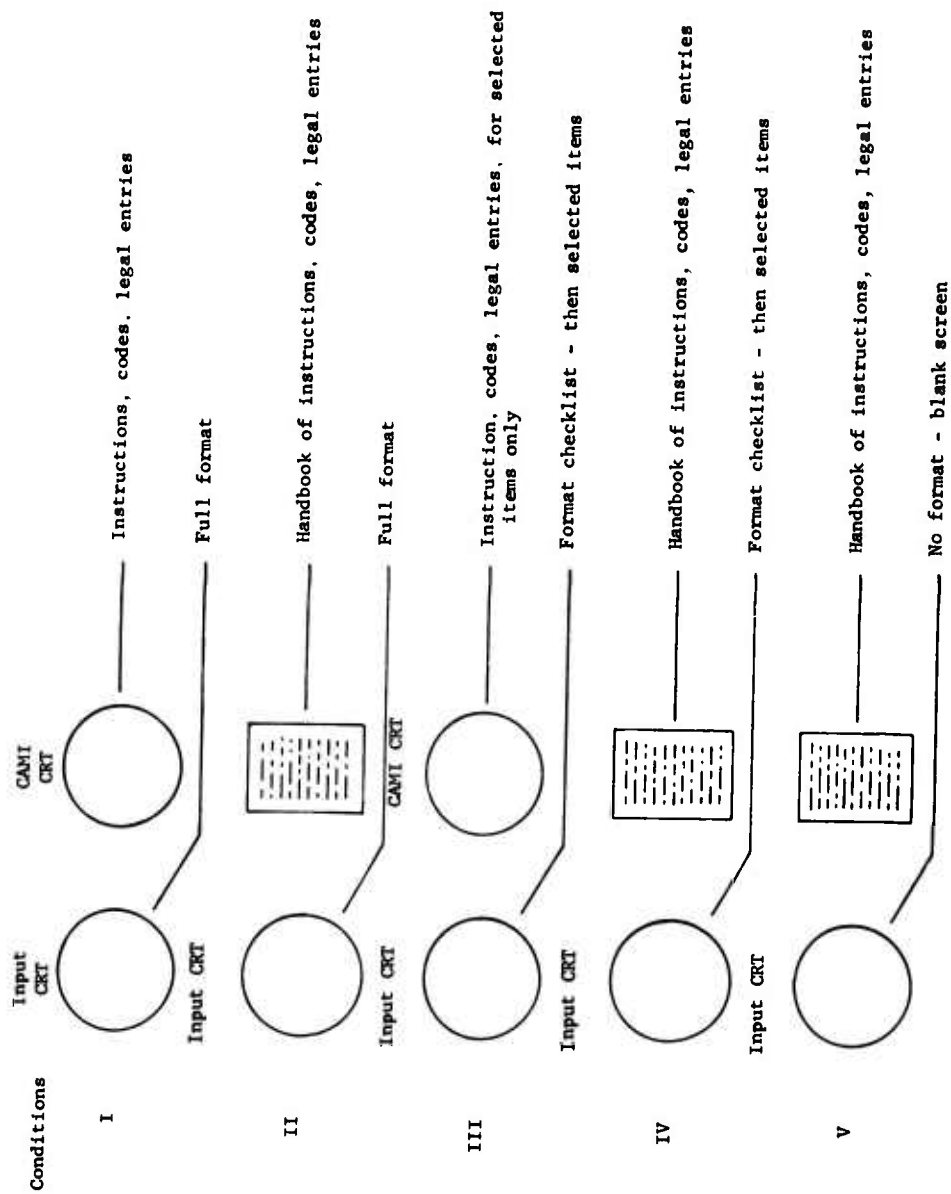
Figure 2. Sample of full format.

UCl FRONT LINE TRACE DATA MESSAGE

THIS MESSAGE ALLOWS THE COMMANDER TO DEFINE THE
POSITION OF HIS TROOPS ON THE GROUND.

MSG-NR: THIS FIVE-CHARACTER FIELD PROVIDES AN
INDEX NUMBER FOR THE MESSAGE. YOU WILL HAVE TO
NUMBER EACH MESSAGE CONSECUTIVELY, STARTING AT
3a   45601. THIS IS A REQUIRED ENTRY.

UCl FRONT LINE TRACE DATA MESSAGE

PREC: THIS IS THE PRECEDENCE OF THE MESSAGE.
YOU WILL SEND ALL MESSAGES WITH A PRECEDENCE OF
[R] (ROUTINE) UNLESS OTHERWISE SPECIFIED. THIS
IS A REQUIRED ENTRY.

MEANING	LEGAL ENTRY
ROUTINE	R
PRIORITY	P
IMMEDIATE	I
FLASH	F

3b

Figure 3. Sample of first two CAMI displays for format shown in Figure 2.

UC1 FLT COORD DATA LIST

- RESTR
- UNIT-ID-OR-TF-NAME
- FLT-COORD-1
- FLT-COORD-2
- FLT-COORD-3
- FLT-COORD-4
- FLT-TIME
- CO-ON-LINE-POSIT
- BN-ON-LINE-POSIT
- LT-COORD-PT
- LT-COORD-PT-TIME
- RT-COORD-PT
- RT-COORD-PT-TIME

Figure 4. Sample of format checklist.

```
UC1 FLT COORD DATA
MSG-NR[      ]PREC[   ]SCTY[   ]ORIG[        ]
UNIT-ID-OR-TF-NAME[                        ]
FLT-COORD-1(          )FLT-COORD-2(           )
FLT-COORD-3(          )FLT-COORD-4(           )
FLT-TIME(          )
CO-ON-LINE-POSIT ( / )
```

Figure 5. Sample of format after subject has completed checklist.

In Condition V, the subject was provided with a single blank-screen CRT and a handbook containing the instructions and legal entries. He was required to type in both the data entry item name and the appropriate data.

Independent Variables

The experiment was conducted as a 2x2 factorial with two methods of format, and two levels of CAMI (Table 2). The Blank Format condition (V) was compared with the other handbook conditions (II, IV) in a separate analysis. As shown in Table 2, 12 subjects were randomly assigned to each experimental condition.

Table 2

EXPERIMENTAL CONDITIONS

Format	Input Assistance	
Method	CAMI CRT	Handbook
Full	(I) S_1-S_{12}	(II) S_{13}-S_{24}
List	(III) S_{25}-S_{36}	(IV) S_{37}-S_{48}
Blank	--	(V) S_{49}-S_{60}

Note. S = Subject.

Dependent Variables

The dependent variables were accuracy and speed. Accuracy was measured as the percent correct of the total number of format entries. Thus, for each formatted message, an accuracy score was computed as: Accuracy = Number of correct data entries/Total number of entries. Speed was initially measured from the time of completion of one format to the time of completion of the next. Later the computer program was revised to separate the time required for the message to be typed, the time taken by the subject to select a format, and the time consumed in composing the format. Speed could then be measured as elapsed time between the selection of a message format and the completion of that format. Thus, for the checklist conditions (III and IV) the elapsed time included the time required to place an X beside the items to be completed.

Because this programming revision occurred after ten subjects had completed the experiment (2 per condition), the sample size for time scores was reduced from 12 to 10 per condition.

The experiment was concerned with obtaining an estimate of accuracy and speed of performance after the basic task was well understood by subjects. Therefore, the first seven formats completed by each subject were considered practice exercises and were not included in the analyses.

The present experiment was designed to investigate the overall effects of CAMI and formatting method on the accuracy and speed of message inputting. A median accuracy and a median format-completion time was obtained for each subject. The average median accuracy for each group of 12 subjects is shown in Figure 6. Two analyses of variance were conducted on these scores; the first considered the first four conditions in a 2x2 design (I-IV design) and the second compared condition V with condition II and condition IV (II, IV, V design). All effects in both analyses were nonsignificant. The average median format-completion time for each group of 1ᵉ subjects is shown in Figure 7. Two analyses of variance similar in design to those for the accuracy scores were conducted on these completion-time scores. The I-IV design analysis yielded no significant differences. The II, IV, V design resulted in an $F(2,27 \text{ df})$ of 3.84, significant at the .05 level. A Newman-Keuls sequential range test identified the source of this effect as a significant difference $(p < .05)$ between the average median format-completion times of condition II and condition V, a difference of 4.6 minutes.

The data were characterized by a high degree of variability (Table 3), which obscured any real experimental effects which may have been operating. Thus the difference of nearly two minutes per format between the full format (I,II) and the checklist (III,IV) conditions was insufficient, in the light of score variability, to result in a significant F in the analysis of variance.

Friendly vs. Enemy Messages

The scenario package used in the present experiment contained one enemy message format and nine friendly message formats. Also, friendly and enemy messages were not equally distributed throughout the scenario. Thus, differences in performance comparisons between friendly and enemy format completion accuracy and speed may have been due to a peculiarity of the single enemy format used or to the uneven distribution of friendly/ enemy messages. However, for baseline purposes and because there is little other data on the question, performance differences between friendly and enemy inputting accuracy and speed will be reported.

For all conditions of the experiment, friendly formats were completed with greater accuracy and speed than enemy formats. The enemy messages were intuitively felt to be more difficult to format than the friendly messages, requiring more analytic and subjective judgments on the part of the subject. An analysis of variance on data from the four main experimental conditions (I-IV) revealed that the mean accuracy of 76.9% for friendly formats was significantly greater than the mean accuracy of 69.6% for enemy messages, $F(1,44 \text{ df}) = 20.54$, $p < .001$. The mean inputting speed of 7.1 minutes for conditions I-IV was significantly

CAMI CRT

Instructions, codes, legal entries

Full format

Input CRT

77.3%

I

Handbook of instructions, codes, legal entries

Full format

CAMI CRT

Input CRT

69.1%

II

Instruction, codes, legal entries, for selected items only

Format checklist - then selected items

Input CRT

72.8%

IIi

Handbook of instructions, codes, legal entries

Format checklist - then selected items

Input CRT

72.9%

IV

Handbook of instructions, codes, legal entries
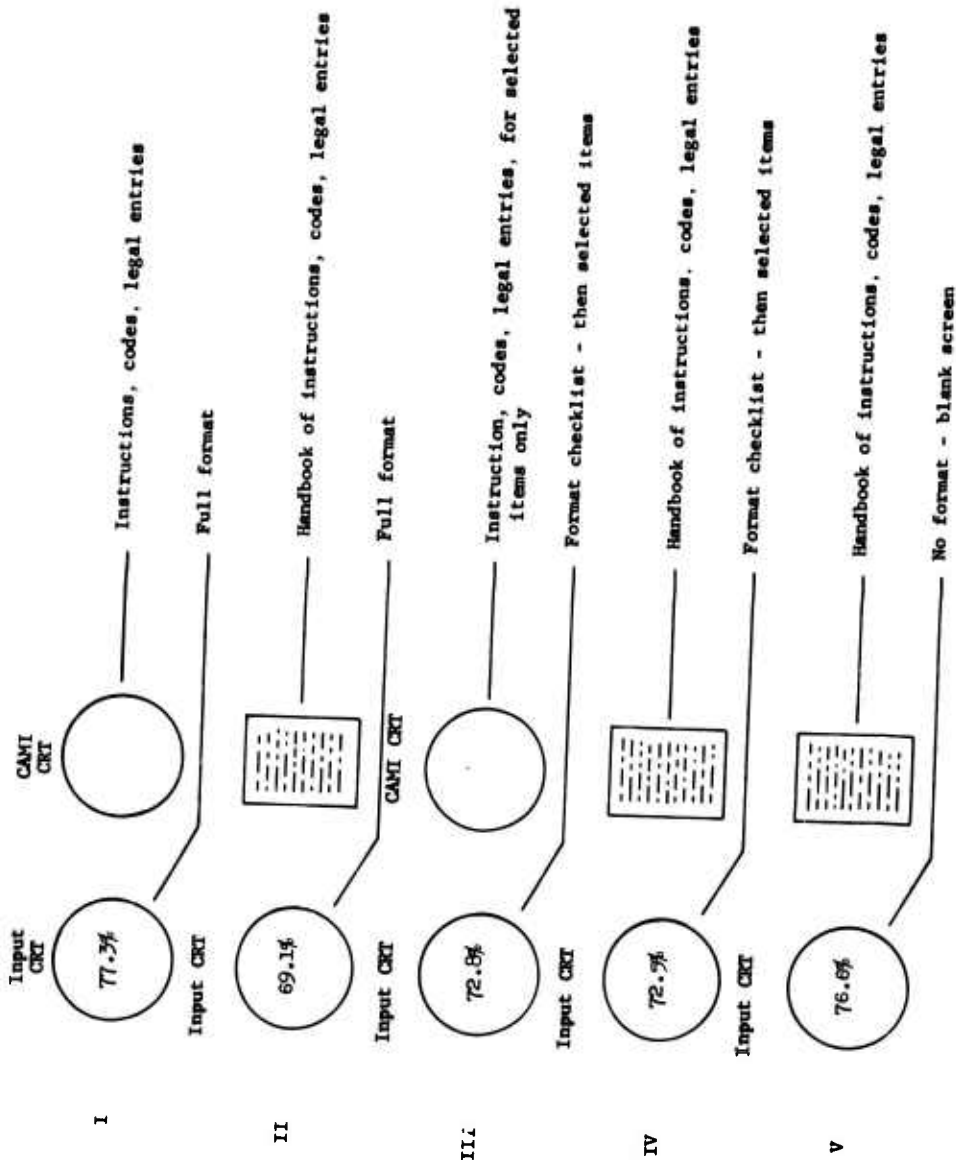
No format - blank screen

Input CRT

76.6%

v

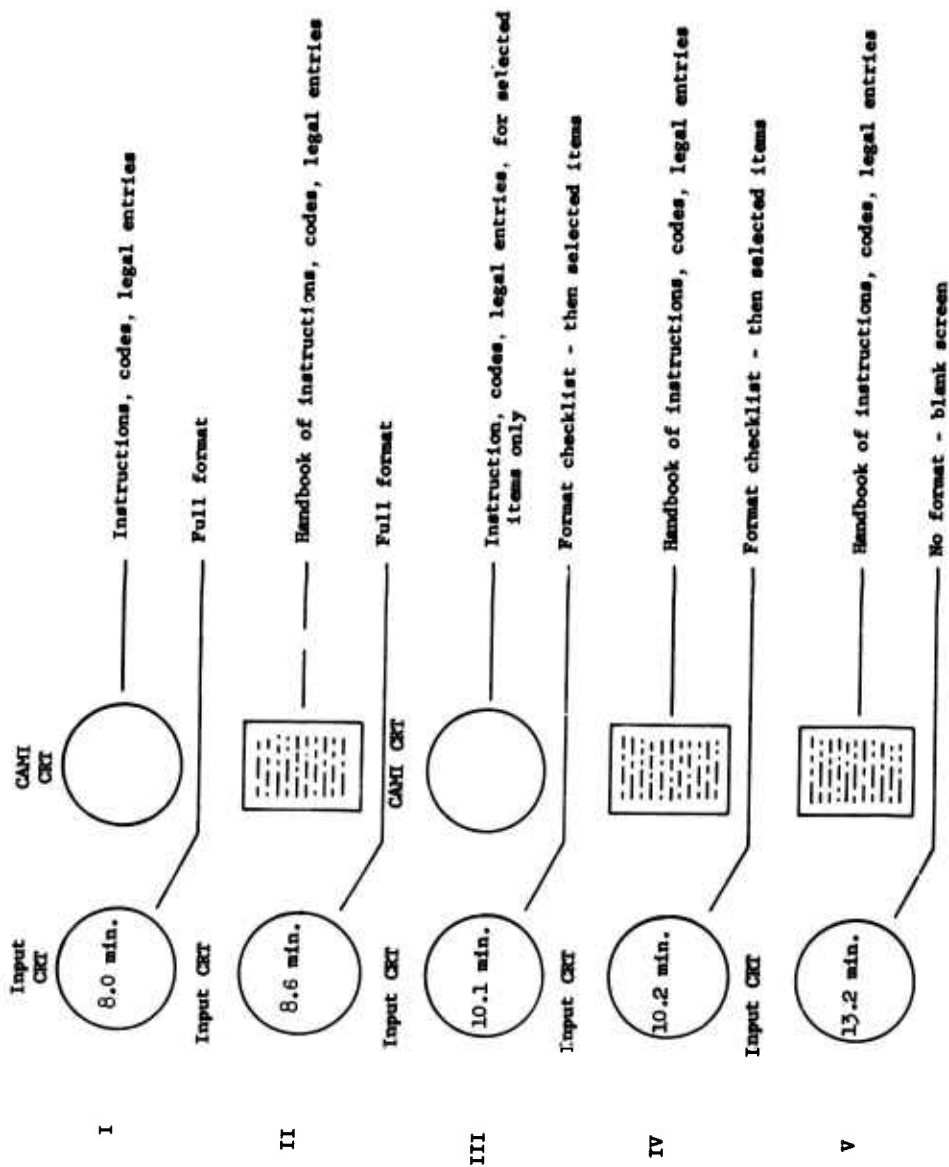Figure 6. Average median accuracy across conditions (N = 60)

Figure 7. Average median format completion time across conditions (N = 50)

Table 3

MEDIAN FORMAT-COMPLETION TIME IN SECONDS
FOR EACH SUBJECT IN EACH CONDITION

Subjects Within Condition	Experimental Condition				
	I	II	III	IV	V
1	285	336	329	475	455
2	348	392	358	484	511
3	408	429	378	490	635
4	410	439	454	506	663
5	427	516	464	522	689
6	442	524	496	531	729
7	467	533	517	532	776
8	509	535	518	558	887
9	520	701	775	883	1187
10	1023	764	1769	1150	1383

faster than the 11.8 minutes per format time required to input enemy
messages, $F(1,36) = 104.37$, $p < .001$. Thus in the present experiment the
enemy messages were more difficult to input than friendly messages; the
enemy formats were less accurate and required more time to complete.
However, the design of the experiment was more concerned with providing
a realistic scenario to subjects than with controlling for number and
distribution of friendly and enemy messages. Thus the generalizability
of friendly/enemy differences found here is questionable.

Probability of Undetected Error

Overall accuracy scores represented the sums of each of six different
error types identified in the present research. The six types of errors
and their definitions are:

1. Commission error--subject enters data in a space which should
have been left blank.

2. Omission error--subject leaves a space blank when it should have
been filled.

3. Glossary error--subject enters data in the correct space which are incorrect for the entry at hand. For example, selection of an incorrect entry from a legal entry table would result in a glossary error.

4. Category error--subject enters data which belong in a different item entry space. Thus, if a subject enters a unit location in a date-time space he commits a category error.

5. Abbreviation error--subject incorrectly abbreviates an entry. Very often it is difficult to decide whether a subject has made an abbreviation error or a typographic error. For example, if a subject enters "TNKS" and the correct answer is "TANKS" he may have made an abbreviation error or simply forgotten to type an "A" after "T". Thus as an operational definition an abbreviation error was defined as a typographic error which occurs more than once.

6. Typographic error--subject types an incorrect character, omits a character, or spaces incorrectly while completing an entry.

Categorizing the different types of errors permits identification of which types of errors would be detected and which would not be detected by an automated edit and validation routine such as the one planned for TOS[2]. A known ratio of undetected to detected errors is useful for real-world information systems, for which answer sheets are not usually available. If valid, it would allow one to estimate on the basis of detected errors the numbers of errors which entered the system undetected.

Of the types of error listed above, commission, omission, and glossary errors will be undetectable by computer error checking. One exception is the case of mandatory entries in which the computer would detect omission errors. However, in this experiment as well as an earlier experiment,[9] mandatory entries were seldom omitted.

Table 4 shows the error rates for each error type, both detectable and undetectable, under friendly and enemy conditions. A very striking point is the fact that most of the errors identified in this experiment would not have been caught by a computerized edit and validation routine. For both friendly and enemy conditions the ratio of undetected to detected errors is more than four to one.

The high ratio of computer-undetected to detected errors in the present research suggests that users should be trained to a high level of proficiency prior to using the system. However, when such systems are fielded and are operating in a combat environment it may not be possible to have trained personnel on hand for replacements. One solution to this difficulty would be to incorporate an automated training package into the

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[9] Strub, 1971, op. cit.

Table 4

MEAN ERROR RATES FOR EACH ERROR TYPE
ACROSS FRIENDLY AND ENEMY MESSAGES

Error Type	Friendly		Enemy	
	Error Rate	% Total	Error Rate	% Total
Not detectable				
Commission	.064	28%	.018	6%
Omission	.053	23%	.148	48%
Glossary	.069	30%	.087	29%
	.186	81%	.253	83%
Detectable				
Category	.018	8%	.023	8%
Abbreviation	.001	0%	.013	4%
Typographic	.026	11%	.016	5%
	.045	19%	.052	17%

system. Such a package would allow the user to sit down at the very device he will be operating and receive automated instruction on the task of transforming and inputting tactical data.

What is the difference between the automated training program advocated above and the CAMI procedure explored in the present experiment? The key difference is that CAMI was designed to function operationally in a real message inputting situation. An automated training program, on the other hand, would make maximal use of feedback or knowledge of results in the course of bringing a user to a desired level of proficiency prior to assigning him duty as a regular operator.

Automated training such as this poses a real challenge in terms of discovering an optimal strategy for carrying out the instruction. Atkinson and Paulson,[10] in discussing the psychology of instruction, point out the capability of the computer for administering parameter-dependent

[10]Atkinson, R. C. and J. A. Paulson. An approach to the psychology of instruction. Psychological Bulletin, 1972, 78, 49-61.

optimization strategies. This is possible because of the ability of the computer to be sensitive to each individual's response and sets of responses. Parameter-dependent models are potentially valuable because they take into account individual differences among learners.

SUMMARY

In summary then, it may be stated that the CAMI aid had no significant effect on the time required to transform and input free-text messages into the computer's data base. The checklist method also had no significant effect on message processing time over the full-format method. The blank-screen condition, however, required a significantly greater amount of time to process messages. The CAMI aid and checklist method had no apparent effect on accuracy.

Messages requiring the enemy format were more difficult and required more time to process than messages requiring friendly formats, but for reasons discussed earlier this finding should not be generalized.

There appears to be a great danger that most errors in on-line data inputting systems may not be detectable by computerized error-checking routines. Over 80% of the errors in the present experiment would not have been caught by such a routine. An automated training package to be inserted into the system might reduce errors by providing needed instruction to less experienced operators.

CONCLUSIONS

The primary objective of the present experiment was to evaluate (1) a computer-assisted message inputting (CAMI) aid which automatically provided to the input operator information useful for completing the format, and (2) a checklist method of formatting free-text information into computer-acceptable terminology. The dependent variables were the accuracy and the speed of message inputting as measured by median accuracy and median format-completion times. Analyses of variance on these scores revealed no significant effects attributable to CAMI or the format checklist method.

The present experiment, however, demonstrated the need for separating overall error rates into component categories. Categorization of errors makes it possible to determine the probability that an error would be detected by an automated error-correction procedure. Such a statistic could be used to estimate the frequency with which errors go undetected into a real-world, on-line information system. In the present experiment, over 80% of the errors would not have been detected by a computerized edit and validation routine.

According to this finding, computerized error checking may not substantially compensate for lack of proficiency on the part of the input operator. However, in the tactical environment in which this system may operate, a large reserve pool of trained personnel may not be available. One response to this contingency would be to incorporate an on-line training program into the system. Additional research is necessary to determine the optimal strategy for carrying out such a program of instruction.

APPENDIX

PRELIMINARY EXPERIMENTAL INSTRUCTIONS

The experiment in which you are participating is designed to test the relative efficiency of several methods of entering data into a military computer.

You will be placed in a fictionalized combat situation and will be asked to enter data into a computer terminal as directed by your CO, or his S2 and S3. The coordinates you will enter correspond to the mapsheet in front of you and you are encouraged to use it to follow the progress of the "battle", if you wish.

Messages will arrive, one at a time, via the typewriter on your right. You are <u>not</u> expected to be able to complete <u>all</u> messages in the time allotted you. Work at your own rate and remember that accuracy is most important.

Many times you will be given messages, all of whose data elements are <u>not</u> on the list of legal entries. In these cases, use your own judgment to choose the legal entry most closely approximating the word in the message.

Once again, remember that speed is not vital in this experiment, but accuracy is.

We appreciate your cooperation.

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